

May 10, 2016

2486

Bob Schumacher, P.E.
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Idaho Transportation Department
2600 Frontage Road, PO Box 837
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Geotechnical Evaluation
SH-14, Slide Repair near Elk City
Idaho County, Idaho
Project No. A019(782), Key No. 19782

Dear Mr. Schumacher:

In accordance with your request, we have prepared this letter report summarizing our geotechnical evaluation of the State Highway 14 (SH-14) landslide near milepost (MP) 39 west of Elk City, Idaho. A summary of our site reconnaissance, subsurface investigations, and recommendations for mitigation measures is included below.

Background

SH-14 is an east-west oriented highway that follows the South-Fork of the Clearwater River from Elk City to its junction with SH-13 near Grangeville, Idaho (Figure 1). On February 18, 2016, a large landslide buried approximately 250 feet of the highway near MP 39, 10.5 miles west of Elk City, Idaho (Photo Exhibits 1 through 3). The slopes adjacent to the highway at this site have been historically active with frequent rockfall activity. A smaller landslide occurred at this site in 2011 (see Photo Exhibit 4). Based on published satellite imagery, signs of slope instability date back to at least 1992.

The February 2016 landslide cutoff access to and from Elk City. Immediately following the event, Idaho Transportation Department (ITD) maintenance crews began clearing debris from the roadway, while their engineering staff developed a mitigation plan and construction documents for a contract to repair the slide and re-establish access to Elk City. The mitigation plan developed by ITD included excavation of unconsolidated materials above the headscarp of the landslide followed by removal of active slide debris. West Company, Inc. (WestCo.) from Spokane, Washington was awarded the contract to perform the slide removal and slope re-grading (excavation) mitigation work.

Landslide Technology (LT) was retained by ITD to review the mitigation plan, recommend additional mitigation options (if necessary), and provide technical guidance and observation services during construction. Two senior representatives from our firm visited the site between

March 12 and 16, 2016 to observe landslide features and to gain a better understanding of the existing conditions. At that time, WestCo. was in the process of clearing slide debris from the road grade. Observations and recommendations from our initial site reconnaissance are summarized in our *Initial Site Observations* memo dated March 16, 2016, which is provided in Appendix A.

During the initial site visit, ITD requested our opinion on whether or not construction should proceed immediately or be postponed until the drier summer months. Due to the sensitivity of the landslide to water and the time of the year in which construction would be conducted (i.e. spring time), it was recommended that ITD consider delaying construction until summer. ITD determined the construction efforts would proceed to facilitate re-establishing access to Elk City on a limited basis. The first step in the construction process was to construct a temporary shoofly road to allow limited access through the slide area (Photo Exhibit 5).

While WestCo was constructing the temporary shoofly road, a fast-tracked subsurface investigation was performed to gain a better understanding of the subsurface materials and the depth to bedrock. This information was used to refine ITD's mitigation plan. The subsurface investigation was performed from March 27 to 30, 2016 and is summarized below. Our recommendations for modifying ITD's excavation plan are summarized in our *Excavation Limit Concepts* memo dated April 5, 2016, which is provided in Appendix B. Excavation work began in early April 2016 and is currently underway.

Regional Geology

SH-14 passes through the Rocky Mountain System physiographic province, which is comprised primarily of Precambrian metamorphic and meta-sedimentary rocks, and Mesozoic igneous intrusions that have undergone intense folding and faulting as part of the Laramide Orogeny. Pleistocene glaciation scoured channels for many of the streams leaving overburden and erosional deposits on the summits of the mountains. Bedrock in the project area is comprised of highly foliated metamorphic gneiss and schistose rocks with pegmatitic intrusions of Mesoproterozoic age and undivided intrusive rocks. These are described as consisting of biotite-rich para-gneiss and schist, and subordinate calc-silicate rocks.

Numerous faults in the region show a general north-south trend near the project site with some faults trending northeast-southwest to the east of the project site and secondary faulting west of the project site trending roughly west-east. The South Fork of the Clearwater River appears to be controlled by this regional faulting. In general, the river flows from east to west; however, there are numerous meanders in the river that flow in a north-south direction. The slide at MP 39 is at a location where the river flow is forced to the south, most likely indicating a major north-south fault is directly adjacent to the site. Secondary faulting, which trends west-east, is also evident. The southern lateral scarp of the slide appears to be associated with these secondary fault features. The rock in areas where primary and secondary faulting intersect have likely been distressed and altered. This results in localized zones where rock is more highly fractured and

relatively weaker, likely making the slopes above the river and roadway susceptible to instability such as the slide at MP 39.

Reconnaissance Observations

Two senior representatives from our firm performed a reconnaissance of the slide with an ITD geologist between March 12 and 16, 2016 to observe the limits of the slide and document surficial landslide features. The active portion of the slide is approximately 250 feet wide and over 700 feet long (see Figure 2). The active headscarp, located nearly 350 vertical feet above SH-14, is up to 25 feet in height (see Photo Exhibits 6 and 7). The slide appears to be bound on the south by a secondary regional fault and the north by a slight ridge (see Photo Exhibit 7).

Features observed suggested the slide was not surficial in nature. It appears that the slide movement is complex, occurring both in soil and at the contact with (or within) bedrock. No in-place bedrock was observed within the base of the headscarp or on the slide mass. Highly saturated and soft ground conditions were observed within the slide debris as well as above the slide mass. The two major landslide events (2011 and 2016) occurred during the wetter parts of the year in the winter and spring; indicating elevated groundwater conditions likely played a major factor in the landslide movement. There also appears to be two directions of slide movement, which is likely controlled by regional geologic structures.

It appears that the active portion of the slide is associated with an “ancient” or “paleo” landslide (see Figure 2). These ancient slides initially formed in the geologic past, probably during periods of glaciation and as a result of the regional faulting. Ancient landslides are often marginally stable. Minor changes in slide geometry due to cutting of the toe by streams, earthworks (i.e. excavation or filling), or changes in slide conditions like unseasonable high precipitation can activate a marginally stable ancient landslide. Hummocky terrain along with other distinguishing features in the topography and landforms associated with ancient landslides were observed above and north of the active portion of the slide. However, no active signs of distress or instability were observed in these areas.

Based on the observations made during the slide reconnaissance, a subsurface investigation program was recommended to gain a better understanding of the subsurface materials, determine the depth to bedrock, and better define the depth and extent of the excavation limits.

Subsurface Explorations

A fast-tracked subsurface exploration program consisting of three borings was conducted between March 27 and 30, 2016. Crux Subsurface, Inc. of Spokane Valley, Washington performed the drilling using a Burley 5500 drill rig with support of an A-Star B-3 helicopter for access (see Photo Exhibits 8 and 9). Borings were advanced using HWT casing advancer and HQ3 wireline coring techniques. Two borings (B-1 and B-2) were drilled on the active landslide. B-3 was drilled above and west of the active landslide. Locations are shown on Figure 2. SPT samples were taken in borings B-1 and B-3 at 5-foot intervals until rock was encountered. The

borings were abandoned and backfilled with bentonite chips upon completion of drilling at each location.

Subsurface Conditions

Generally, slide debris encountered within the active landslide (Borings B-1 and B-2) consists of loose to medium dense, gravel- to boulder-sized rock fragments in a matrix of silty sand to slightly clayey silt. This material overlies medium hard (R3) to hard (R4), gray, moderately weathered gneiss and schist. Outside of the active landslide limits (Boring B-3), extremely soft (R0) to soft (R2), brown, decomposed gneiss transitions to medium hard (R3), gray, moderately weathered gneiss with depth. The bedrock encountered in all borings is highly foliated. Detailed descriptions of the subsurface conditions encountered are presented in the Summary Boring Logs and Core Box Photos in Appendix C.

Observations of core samples suggest that there is a disturbed/shear zone located at the boundary between the soil overburden and underlying bedrock. The zone was encountered at approximately 35 feet in B-1 and 42 feet in B-2 (see Figure 3). This weaker seam, referred to as the 'upper limit,' could be the active shear zone. Another relatively weak zone was encountered in the rock at approximately 53 and 54 feet below the ground surface in B-1 and B-2, respectively. This sheared zone (associated with highly foliated biotite-rich bedrock) was used to define a 'lower limit' in the refined excavation plan. It is unclear if movement recently occurred in this zone.

Landslide Mitigation and Recommendations

Upon completion of the slide reconnaissance and subsurface investigations, LT provided options and recommendations for modifying the excavation limits developed by ITD. This information was summarized in our *Excavation Limit Concepts* memo dated April 5, 2016 (Appendix B).

Based on our reconnaissance, we estimated the lateral limits of excavation could be constrained by more favorable rock conditions on the northern and southern sides of the active slide area. Side slopes were estimated to fit or feather into the adjacent topography (Figure 4).

As previously discussed, the conditions of the subsurface materials encountered were used to interpret potential upper and lower bounds for the excavation limits. The lower limit would remove additional material that is potentially unstable, thus reducing the risk associated with future failure events; however, targeting the lower limit for excavation presents construction concerns including the following:

- The materials between 35 and 54 feet may not be suitable for mechanical excavation and may require localized or production blasting.
- Blasting may induce pressures that could damage and weaken the underlying bedrock.
- Rock that is damaged or destabilized as a result of blasting/excavation work will most likely require reinforcement (such as rock dowels).

- Increased excavation volume above the active slide area.
- Longer duration of construction and road closure.

Given these concerns and considering the fast-track nature of this project and the limited amount of data available, we recommended ITD target the interpreted upper excavation limit (see Figure 4). The excavation work should follow the generalized recommendations listed below:

- Utilize mechanical excavation methods (i.e. dozer, excavator, hoe-rams, etc.).
- Minimize blasting for removal of material due to likelihood of damaging underlying rock.
- Over-excavate localized areas of soil and weak rock if quality and stability concerns are observed.
- Minimize removal of material at the toe of the slope and in the ditch line (to avoid undermining).

In addition to the recommendations provided above, we recommend that rock dowels be installed to reinforce potentially unstable rock slabs exposed during the excavation of landslide debris, and unlined (open-hole) drains should be installed to relieve groundwater pressures within in the final excavated rock face. This information was provided in our *Rock Dowel and Unlined Drain Recommendations and Quantities* memo dated April 13, 2016 included in Appendix D.

The number, locations, lengths, and orientations of the rock dowels and unlined drains will need to be determined in the field by ITD's onsite representative based on observations of the excavation slopes and the conditions encountered. For estimating purposes, we assume 2,000 linear feet would be required. This could include 75 to 150 rock dowels, 15 to 30 feet in length. We also assume about 1,000 linear feet of unlined drains would be required. This could include 25 to 50 unlined drain holes, between 30 to 50 feet in length.

The general guidelines and excavation limits (as shown on Figures 3 and 4) were provided to assist ITD with developing a final excavated slope geometry to mitigate the landslide hazards near MP 39. Encountered conditions and hazards during excavation may dictate localized variances to the plan as determined in the field and based on observations of the excavated slopes.

We appreciate the opportunity to be of service to the Idaho Transportation Department on this challenging project. If you have any questions please contact us at (503) 452-1200.

Very truly yours,

LANDSLIDE TECHNOLOGY



Adam Koslofsky, C.E.G.
Project Engineering Geologist



Benjamin George, P.E., C.E.G.
Associate Engineer



Brent Black, C.E.G., R.P.G.
Senior Associate Engineering Geologist



Limitations in the Use and Interpretation of this Geotechnical Report

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross-sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

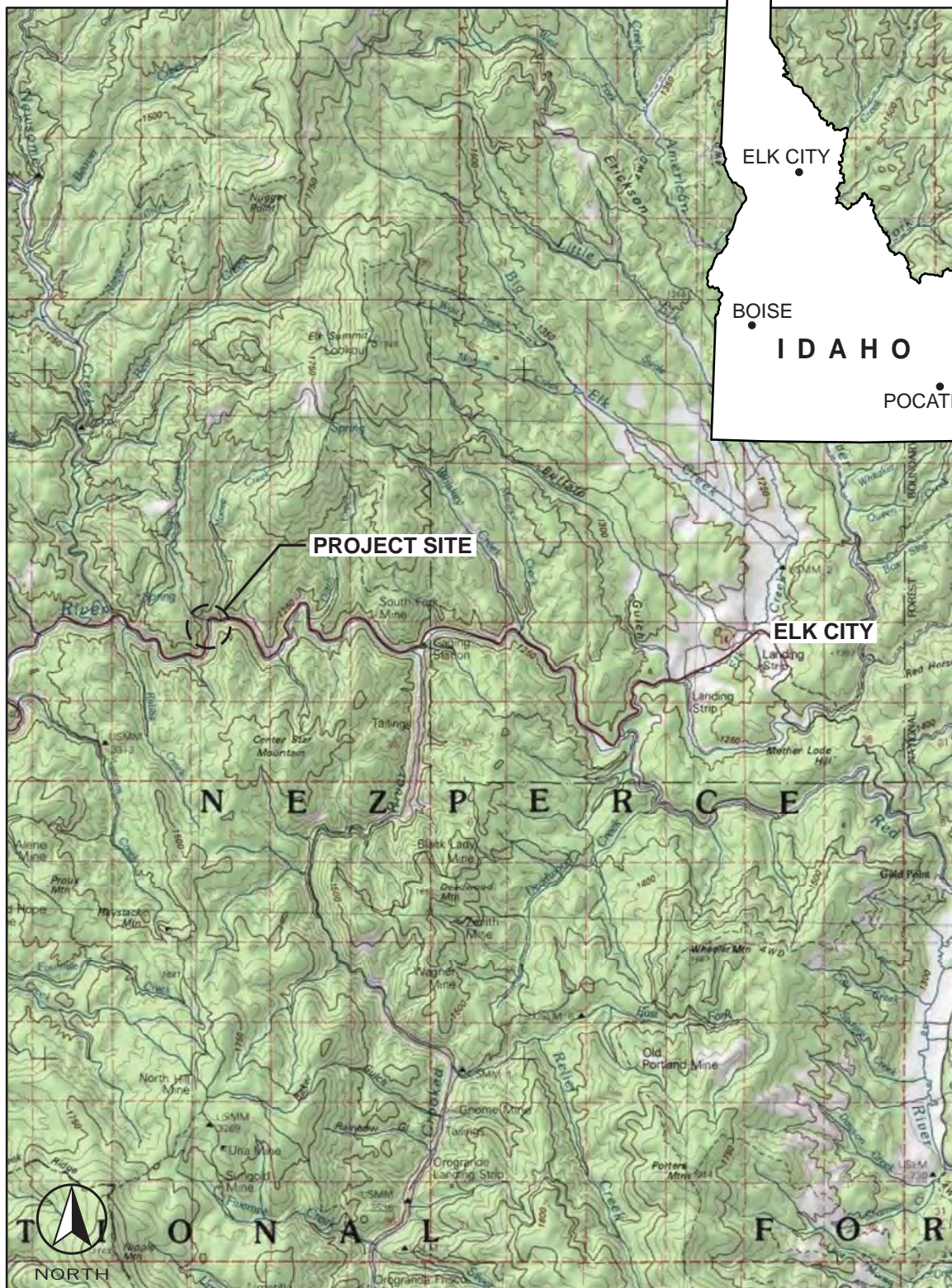
The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.



PROJECT SITE

ELK CITY

N E Z P E R C E



0 2 4

SCALE IN MILES

BASE MAP COPYRIGHT: 2013 NATIONAL GEOGRAPHIC SOCIETY, I-CUBED



**LANDSLIDE
TECHNOLOGY**

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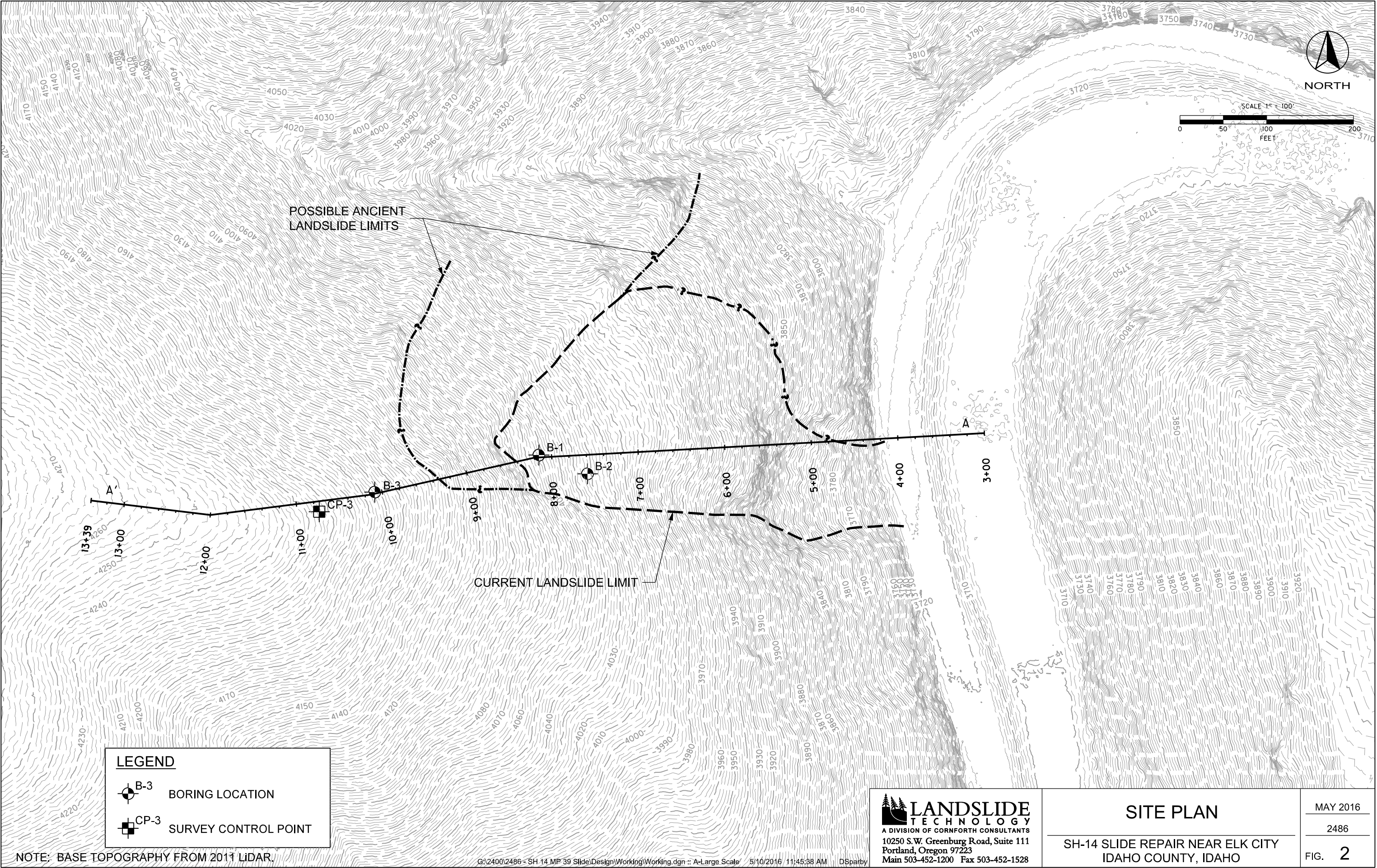
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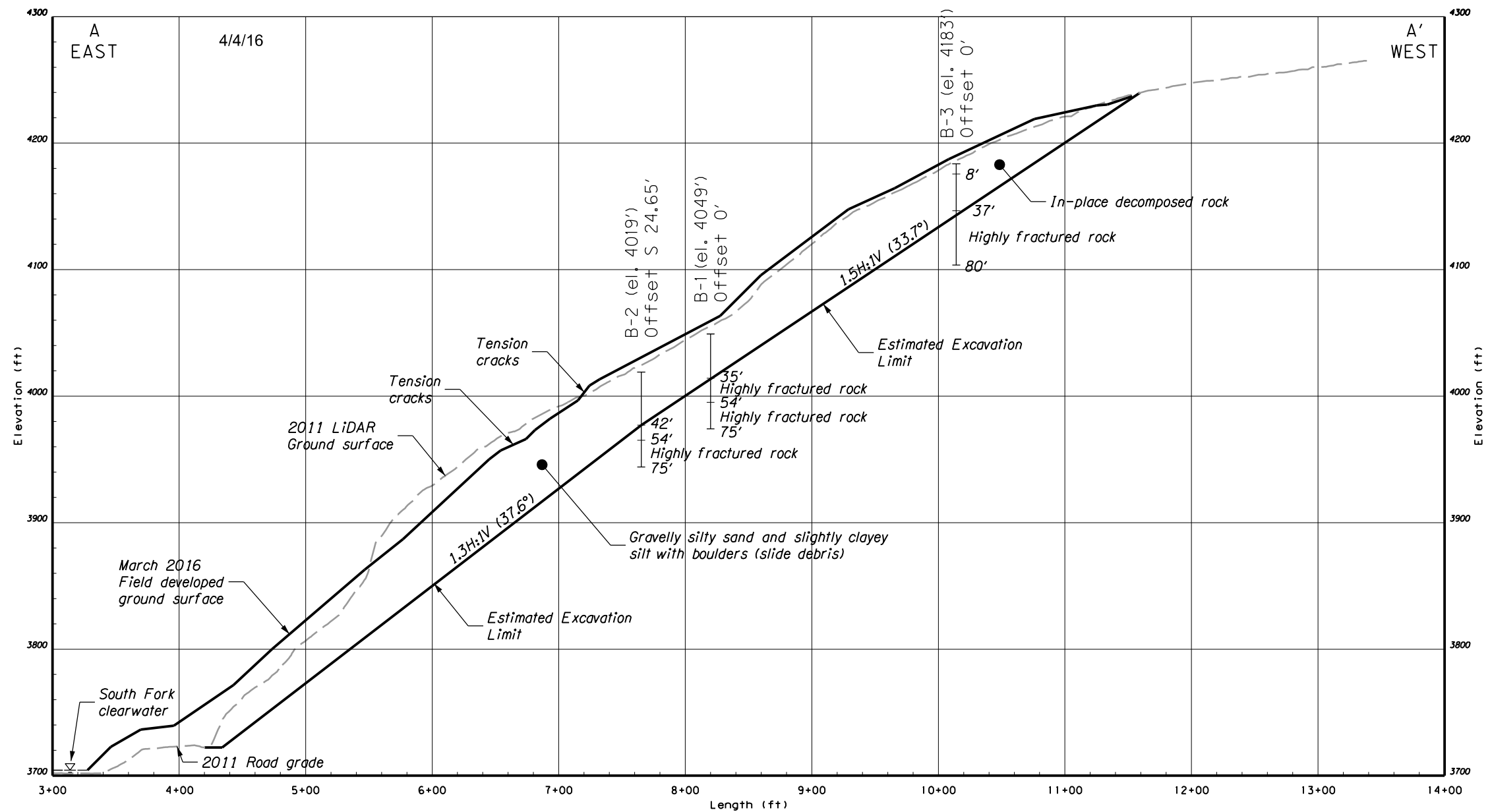
SH-14 SLIDE REPAIR NEAR ELK CITY
IDAHO COUNTY, IDAHO

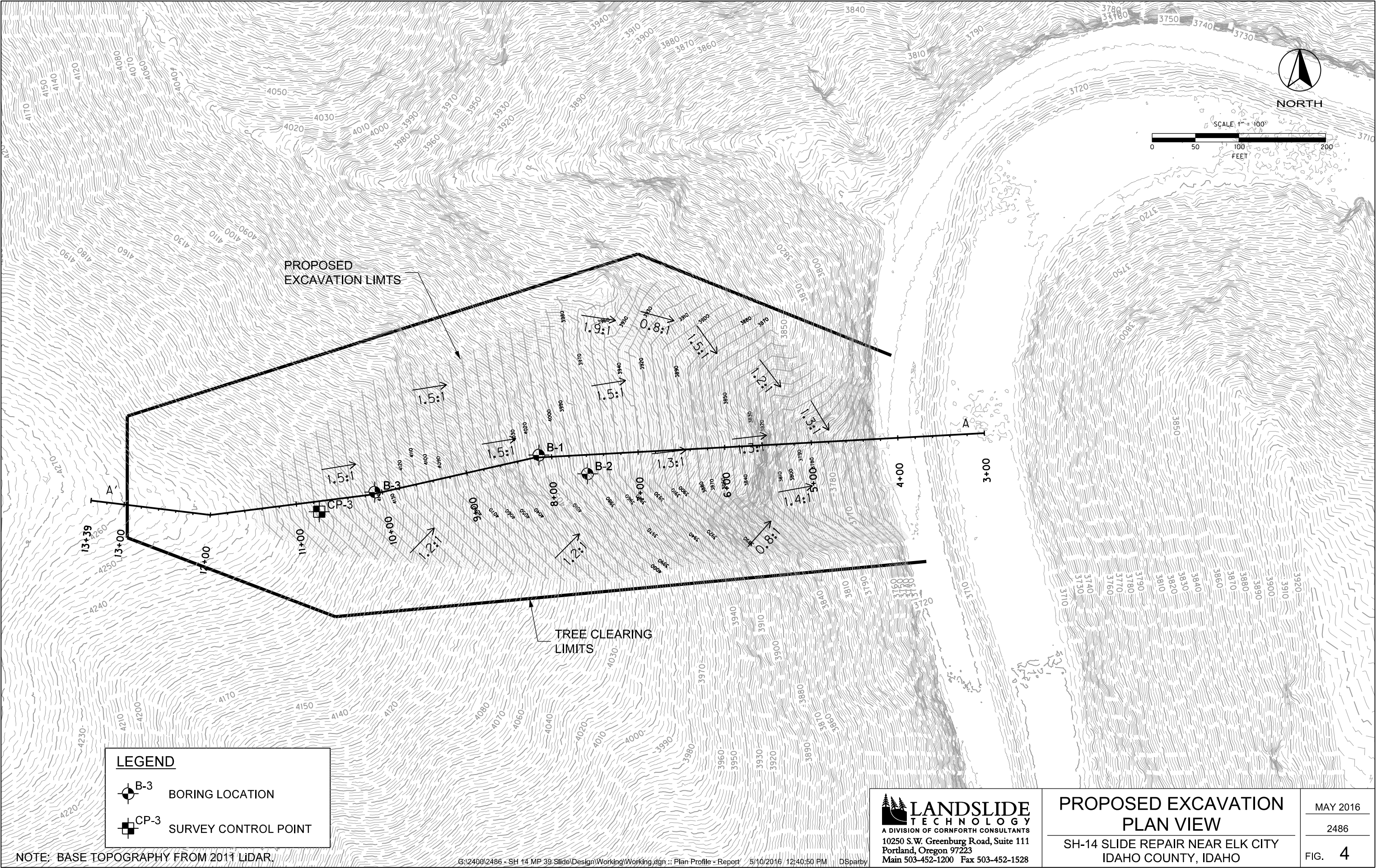
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FIG. 1









A. Aerial view of the landslide looking north (taken on February 19, 2016).



B. View of the landslide looking southwest (taken on March 12, 2016).



A. Aerial view of the upper half of the landslide looking west (March 27, 2016).



B. Aerial view of the lower half of the landslide looking west (March 27, 2016.)



A. View looking south at slide debris that buried SH-14 following the landslide event on February 18, 2016. Note the large rock block within the debris.



B. View looking northwest at the large rock block within the slide debris. The rock block is approximately 30'x70'x50' in size.



A. View looking southwest of the 2011 failure event.



B. View looking southwest of slide debris and rockfall removal efforts in June 2011.



A. View looking south of slide debris being removed and a shoofly road being constructed on March 12, 2016.



B. View looking south of completed shoofly road along toe of slide on April 6, 2016.



A. View looking southwest at the active headscarp of the slide (March 13, 2016).



B. Close-up view of the headscarp (March 13, 2016).



A. View looking south at southern extent of the lateral slide limit near the active headscarp (March 13, 2016).



B. View of the northern extent of the headscarp looking north (March 13, 2016).



A. Photo of the drill on boring B-1 (March 27, 2016).



B. Aerial view of drill rig being dismantled at boring B-1, below the headscarp (March 28, 2016).



A. Photo of the drill on boring B-2 (March 29, 2016).



B. Photo of the drill on boring B-3 (March 30, 2016).

Appendix A
Initial Site Observations Memo

Memo to: Bob Schumacher, P.E.
Maintenance Supervisor, Project Manager
Idaho Transportation Department

From: Brent Black, C.E.G., P.G.
Benjamin George P.E., C.E.G.
Landslide Technology

Date: March 16, 2013

Subject: Initial Site Observations
SH-14, Slide Repair Near Elk City, Idaho
Project No. A019(782), Key No. 19782

In accordance with your request, we have prepared this memo to document our site observations and to summarize discussions from our conference call on March 13, 2016. Two representatives from our firm, Mr. Brent Black and Mr. Ben George visited the site on March 12, 2016 arriving in the late afternoon. We were accompanied by Mr. Brian Bannan of the Idaho Transportation Department (ITD). At that time, we observed the major landslide features that are visible from the road grade. On March 13, 2016, we observed the area above (upslope and west) the slide and the major features on the top of the landslide to gain a better understanding of the current conditions.

Based on our brief time observing the on-site conditions and the current work activities of the contractor we have developed the following understanding of the landslide complex:

- The site is historically active with two major landslide events, frequent rockfall activity and evidence of slope instability dating to at least 1992 as based on published imagery.
- Currently the slide is at or below a factor of safety (FOS) of 1.0.
- The landslide is large ranging up to 700 feet in slope distance by about 250 feet wide.
- Recently gathered seismic refraction data indicates that unconsolidated materials above the current head scarp are likely 35 feet thick or greater.
- We estimate regional geologic structures control the orientation of the slide plane(s).
- It appears movement is complex, potentially with two directions.
- Major movement (2011 and 2016 events) has occurred during the wetter parts of the year in the winter and spring, which is likely due to seasonal increases in groundwater.
- There are highly saturated and soft ground conditions within the slide debris as well as above the slide.

ITD has developed a stabilization concept to excavate the unconsolidated materials above the head scarp, followed by removal of the active slide debris. Given our understanding of the landslide complex and considering the fast track nature of this project and the limited amount of data

available during initial design stages, it is our opinion that the current concept to mitigate the landslide is sound. ITD has requested our opinion of whether or not construction should proceed immediately or postponed until the summer drier months. Due to the sensitivity of the landslide to water and the time of the year in which construction is being conducted, it would be beneficial for the Department to consider delaying construction until summer for the following reasons:

- This will decrease the amount of water infiltration and seepage the landslide may experience during construction and allow the observed saturated and soft ground conditions to improve. Each of these benefits will reduce the risk to worker safety and reactivation of the landslide.
- The contractor could focus on the construction of temporary access through the slide.
- There would be more time for development and construction of temporary protection measures, which could reduce impacts to the local traffic when excavation work begins.
- The condition of the detour route along the forest service roads between Elk City and SH-14 would most likely improve and can be better maintained. If the detour route is more reliable, the use of the temporary access through the construction site could be minimized during construction allowing the contractor to more efficiently mitigate the slide.
- There would be more time to develop a slope stability model.

A slope stability model would be used to gain a better understanding of the existing landslide complex, to estimate the effectiveness of long-term mitigation measures, to evaluate how construction activities will effect interim slope stability, and to estimate the constructability of proposed mitigation measures. To prepare a model the following items are critical:

- Develop a topographic map and cross sections of the slide and adjacent areas.
- Collect subsurface information to characterize the rock and soil properties, thicknesses, and areal extents.
- Install piezometers to monitor groundwater conditions.
- Install slope inclinometers to determine the depth and rate of slide movements.

Proceeding with the current mitigation design has a high risk associated with it due to the wet conditions this time of year and the high level of unknown information. Postponing construction and developing more site information would decrease unknowns and reduce risk.

Limitations in the Use and Interpretation of this Geotechnical Report

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross-sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

Appendix B

Excavation Limits Concepts Memo

Memo to: Bob Schumacher, P.E.
Maintenance Supervisor, Project Manager
Idaho Transportation Department

From: Brent Black, C.E.G., P.G.
Benjamin George P.E., C.E.G.
Landslide Technology

Date: April 05, 2016

Subject: Excavation Limit Concepts
SH-14, Slide Repair Near Elk City, Idaho
Project No. A019(782), Key No. 19782

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In accordance with your request, we have prepared this memo to summarize the excavation models (interpreted Upper and Lower Excavation Limits) shown on the attached figures. These excavation models are derived from the stabilization concept developed by the Idaho Transportation Department (ITD) to excavate the colluvium and relic rock soils above the active head scarp of the landslide, followed by removal of the active slide debris. A limited, fast-tracked exploration program was performed between March 26 and 30, 2016 to determine the depth to bedrock and collect information regarding subsurface materials. The locations of the boreholes are given on the two excavation limit plan views and the depths of the borings, along with a brief description of the materials encountered, are shown on the attached cross section.

Preliminary Subsurface Observations

The landslide debris encountered in borings B-1 and B-2 consists of cobble- to boulder-sized rock fragments in a matrix of silty sand to slightly clayey silt. This material was encountered to an approximate depth of 35 feet in B-1 and 42 feet in B-2, as shown on the attached cross section. The bottom of this material delineates the base of the interpreted Upper Excavation Limits shown on the attached figures. It appears that this material could be excavated primarily using mechanical means.

Below the active landslide debris, a highly fractured and sheared, medium hard (R3), moderately weathered bedrock was encountered to an approximate depth of 54 feet in both B-1 and B-2. This rock is dominated by fractures dipping between 30° and 50°. A relatively weak zone of biotite-mica is present at an approximate depth of 54 feet in both B-1 and B-2. The biotite-mica zone delineates the base of the interpreted Lower Excavation Limits shown on the attached figures. The material from approximately 35 to 54 feet may not be as easily excavated with mechanical methods and may require localized or production blasting to excavate.

Rock below an approximate depth of 54 feet was observed to be hard (R4) and slightly weathered in both B-1 and B-2. This lower material was dominated by fractures dipping between 60° and

80°. This rock was interpreted to be in-place Gneiss and Granodiorite, and is likely in a more stable condition. This material does not appear to be excavatable by mechanical means.

Above the active head scarp, extremely soft (R0), highly weathered to decomposed rock was encountered to depths between 30 to 40 feet in boring B-3. It is not known whether this material has experienced slide movement. It appears that this material could be excavated using mechanical means.

Preliminary Excavation Limits

The lateral extents of excavation will be constrained by more favorable rock conditions on the northern and southern sides. Side slopes were estimated to fit or feather into the adjacent topography. The conditions of the subsurface materials encountered were used to interpret the upper and lower bounds of the excavation limits given on the two plan views. The lower interpreted excavation limit would remove additional material that is potentially unstable, thus reducing the risk associated with future failure events; however, targeting the lower bounds for excavation does have some inherent concerns. They include the following:

- The materials between 35 and 54 feet may not be mechanically excavated and may require localized or production blasting.
- Blasting may induce pressures that could damage and weaken the bedrock.
- Rock that is damaged or destabilized as a result of blasting/excavation work will most likely require reinforcement (such as rock dowels).
- Increased excavation volume of possibly non-slide debris above the active slide area.
- Increased duration of construction and excavation cost.
- Potentially increased road closure duration.

In both cases, lower and upper limits, we feel that rock doweling may be needed to reinforce suspect rock slabs and/or undermined bedrock that has lost its basal support during construction. In addition, there is the potential for individual rockfall to occur during construction and in the long-term as the excavated slope erodes and weathers. The potential savings realized by minimizing the excavation limits could be used to offset the costs associated with rock dowel reinforcement for global stability and rockfall mitigation measures.

Given the above and considering the fast-track nature of this project and the limited amount of data available, the current concept to mitigate the landslide should follow the generalized recommendations listed below:

- Target the interpreted upper excavation limit as close as possible.
- Utilize mechanical excavation methods (i.e. dozer, excavator, hoe-rams, etc.).
- Minimize blasting for removal of material due to likelihood of damaging underlying rock.
- Over-excavate localized areas if quality and stability concerns are observed.
- Stabilize damaged or unstable materials with rock dowels as excavation proceeds and determined in the field (quantity of dowels to be field-determined).

- Stabilize locally in areas that may become unstable as the excavation proceeds to reduce difficult access situations.
- Minimize removal of stabilizing material at the toe of the slope and in the ditch line (to avoid undermining).

The general guidelines and excavation limits are presented to assist ITD with developing a final excavated slope geometry. Encountered conditions and hazards during excavation may dictate localized variances to the plan as determined in the field and based on observations of the excavation slopes.

Limitations in the Use and Interpretation of this Geotechnical Report

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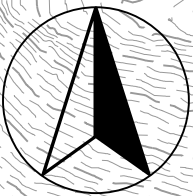
Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

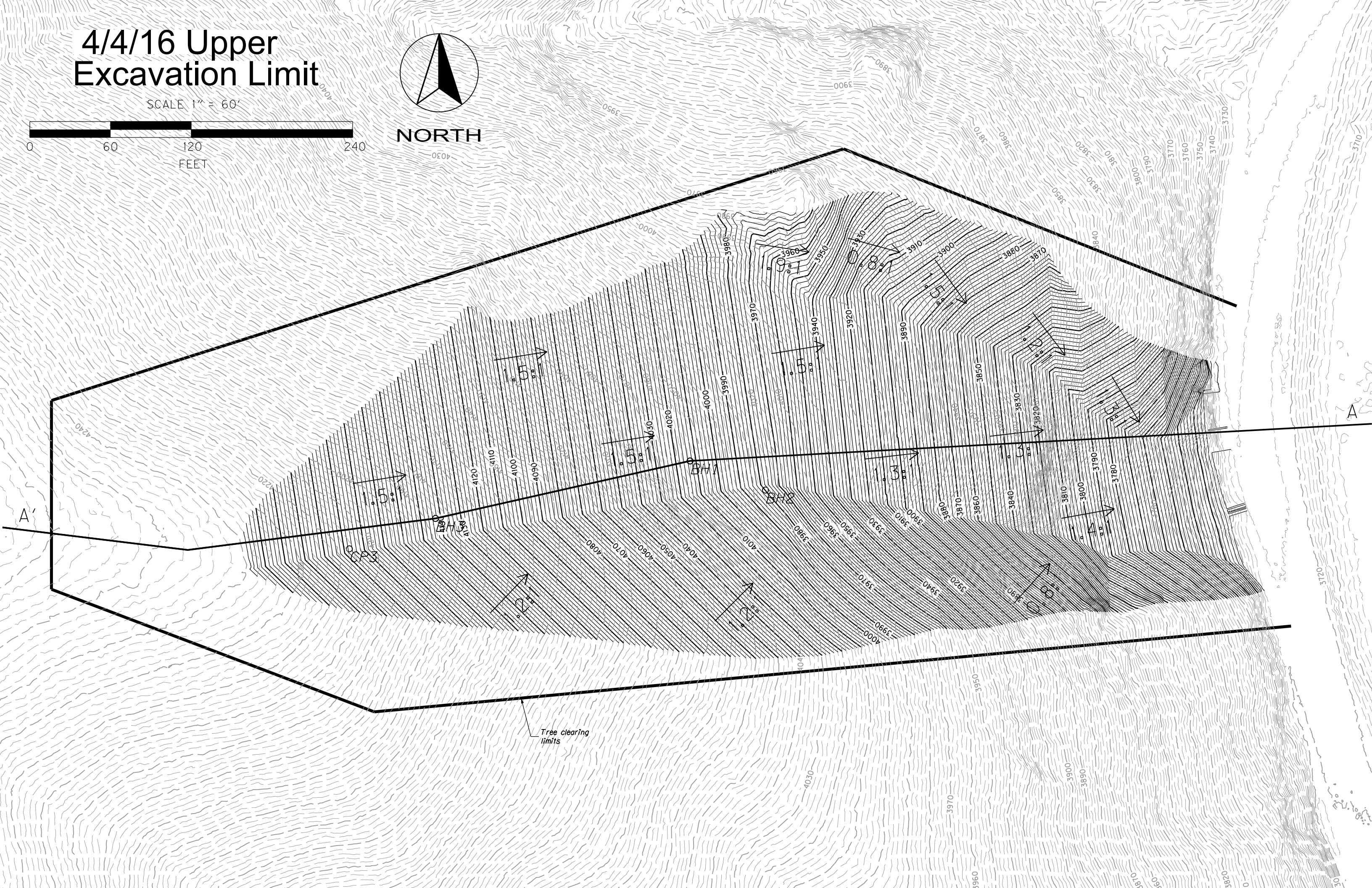
This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

4/4/16 Upper Excavation Limit

SCALE 1" = 60'

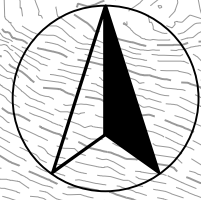


NORTH

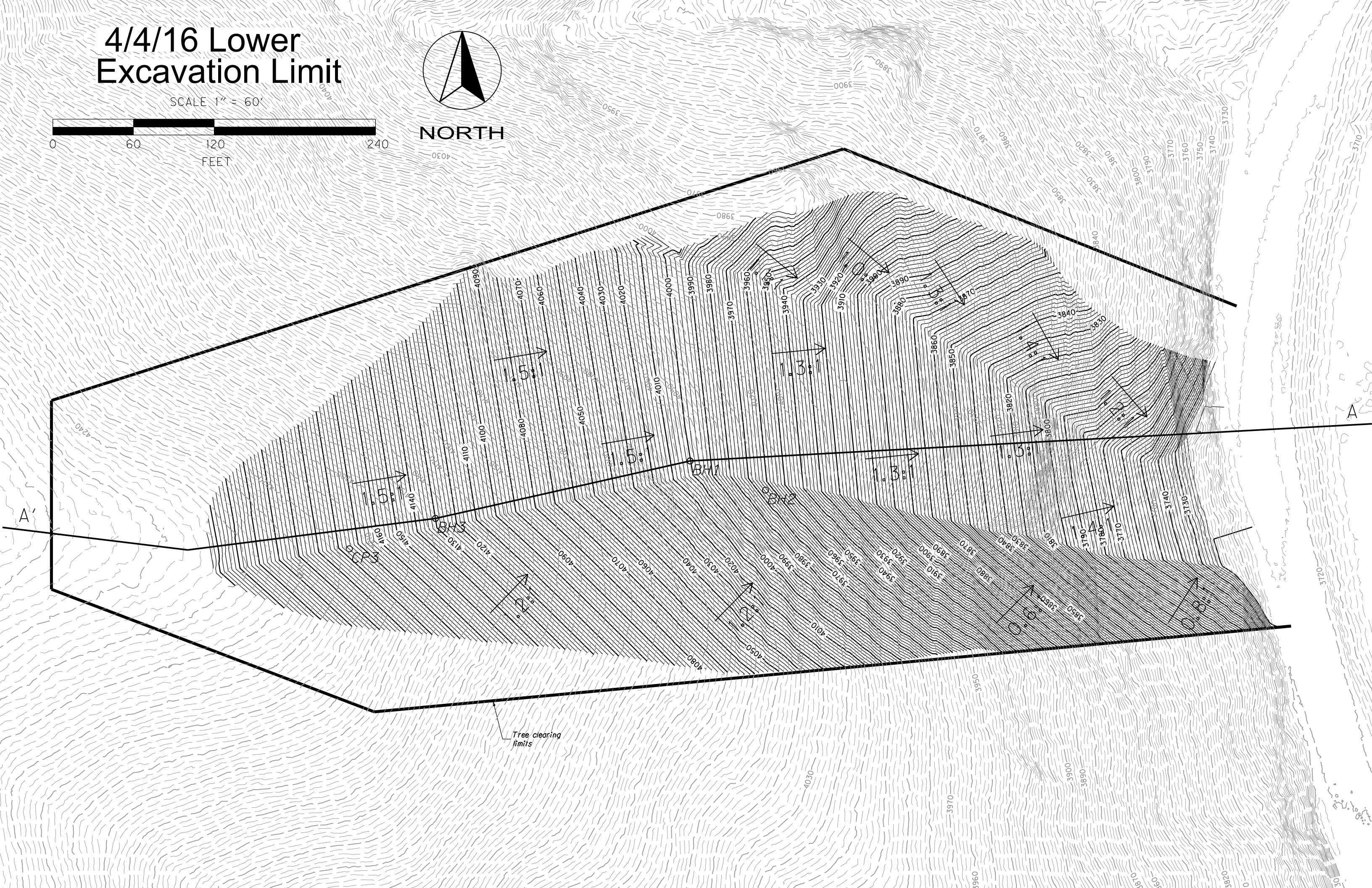


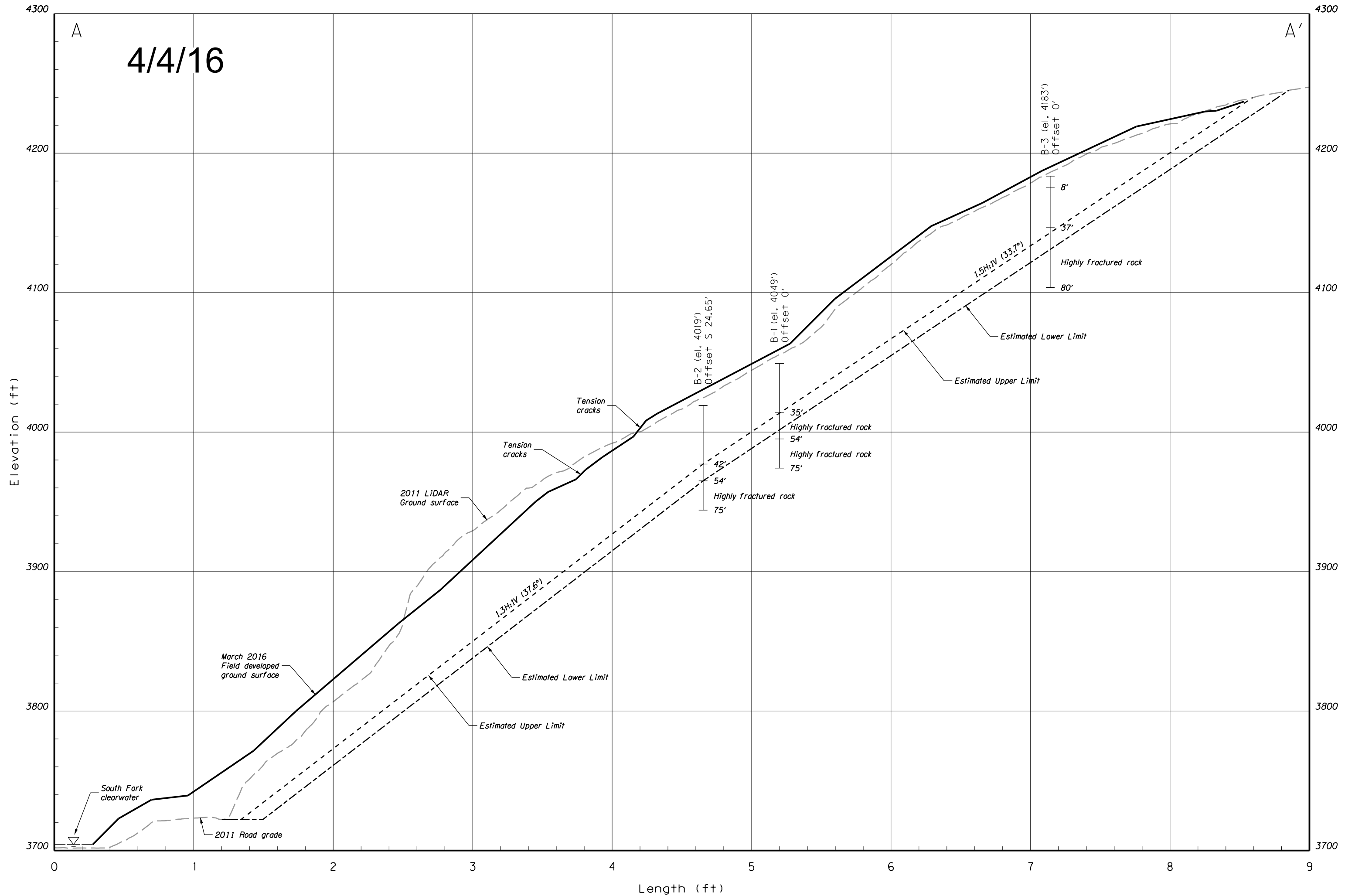
4/4/16 Lower Excavation Limit

SCALE 1" = 60'



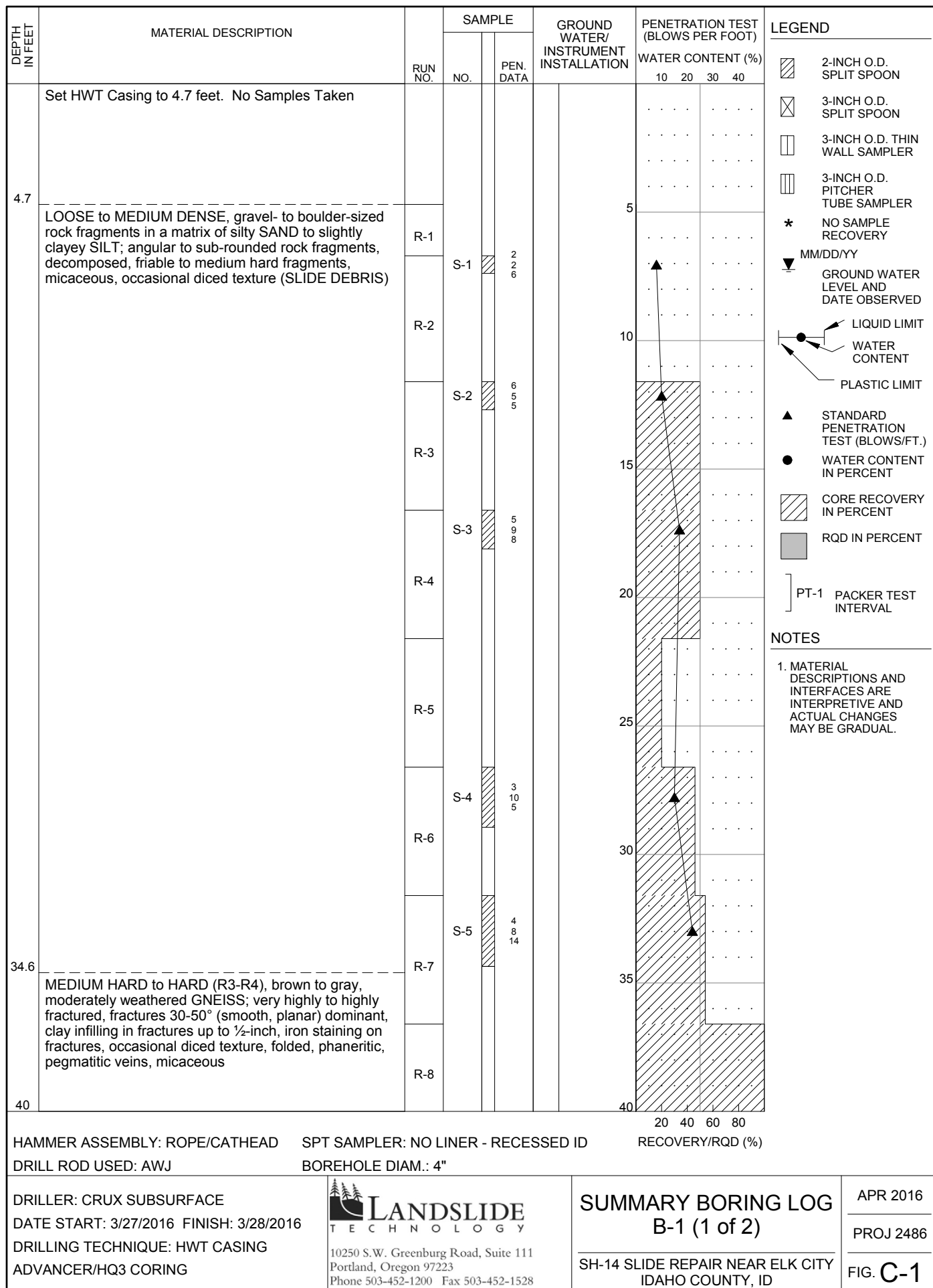
NORTH





Appendix C

Summary Boring Logs and Core Box Photos



| DEPTH IN FEET | MATERIAL DESCRIPTION | RUN NO. | SAMPLE | | GROUND WATER/ INSTRUMENT INSTALLATION | PENETRATION TEST (BLOWS PER FOOT) | | | | WATER CONTENT (%) | LEGEND |
|--|---|---|--------|--------------|--|--|----|----|----|--|---|
| | | | NO. | PEN. DATA | | 10 | 20 | 30 | 40 | | |
| | (continued from previous page) | R-9 | | | | | | | | | <div></div> 2-INCH O.D. SPLIT SPOON <div></div> 3-INCH O.D. SPLIT SPOON <div></div> 3-INCH O.D. THIN WALL SAMPLER <div></div> 3-INCH O.D. PITCHER TUBE SAMPLER <div></div> NO SAMPLE RECOVERY <div></div> MM/DD/YY <div></div> GROUND WATER LEVEL AND DATE OBSERVED <div></div> LIQUID LIMIT <div></div> WATER CONTENT <div></div> PLASTIC LIMIT <div></div> STANDARD PENETRATION TEST (BLOWS/FT.) <div></div> WATER CONTENT IN PERCENT <div></div> CORE RECOVERY IN PERCENT <div></div> RQD IN PERCENT <div></div> PT-1 PACKER TEST INTERVAL |
| 53.9 | ...diced texture from 53.5 to 53.9 feet. | R-10 | | | | | | | | | |
| | MEDIUM HARD to HARD (R3-R4), gray, moderately weathered GNEISS; very highly to highly fractured, fractures 60-80° (smooth, planar) dominant, iron staining on fractures up to 1-inch, folded, phaneritic, pegmatitic veins, micaceous (BIOTITE GNEISS and SCHIST) | R-11 | | | | | | | | | |
| | | R-12 | | | | | | | | | |
| | | R-13 | | | | | | | | | |
| | | R-14 | | | | | | | | | |
| | | R-15 | | | | | | | | | |
| | | R-16 | | | | | | | | | |
| | | R-17 | | | | | | | | | |
| 76.6 | Bottom of Boring: 76.6 FT | | | | | | | | | | |
| HAMMER ASSEMBLY: ROPE/CATHEAD SPT SAMPLER: NO LINER - RECESSED ID DRILL ROD USED: AWJ BOREHOLE DIAM.: 4" | | | | | | RECOVERY/RQD (%) | | | | 20 40 60 80 | |
| DRILLER: CRUX SUBSURFACE DATE START: 3/27/2016 FINISH: 3/28/2016 DRILLING TECHNIQUE: HWT CASING ADVANCER/HQ3 CORING | | 10250 S.W. Greenburg Road, Suite 111 Portland, Oregon 97223 Phone 503-452-1200 Fax 503-452-1528 | | | | SUMMARY BORING LOG B-1 (2 of 2) SH-14 SLIDE REPAIR NEAR ELK CITY IDAHO COUNTY, ID | | | | APR 2016 PROJ 2486 FIG. C-1 | |



Box 1 – 4.7 feet to 30.6 feet.



Box 2 – 30.6 feet to 40.3 feet.



Box 3 – 40.3 feet to 48.2 feet.



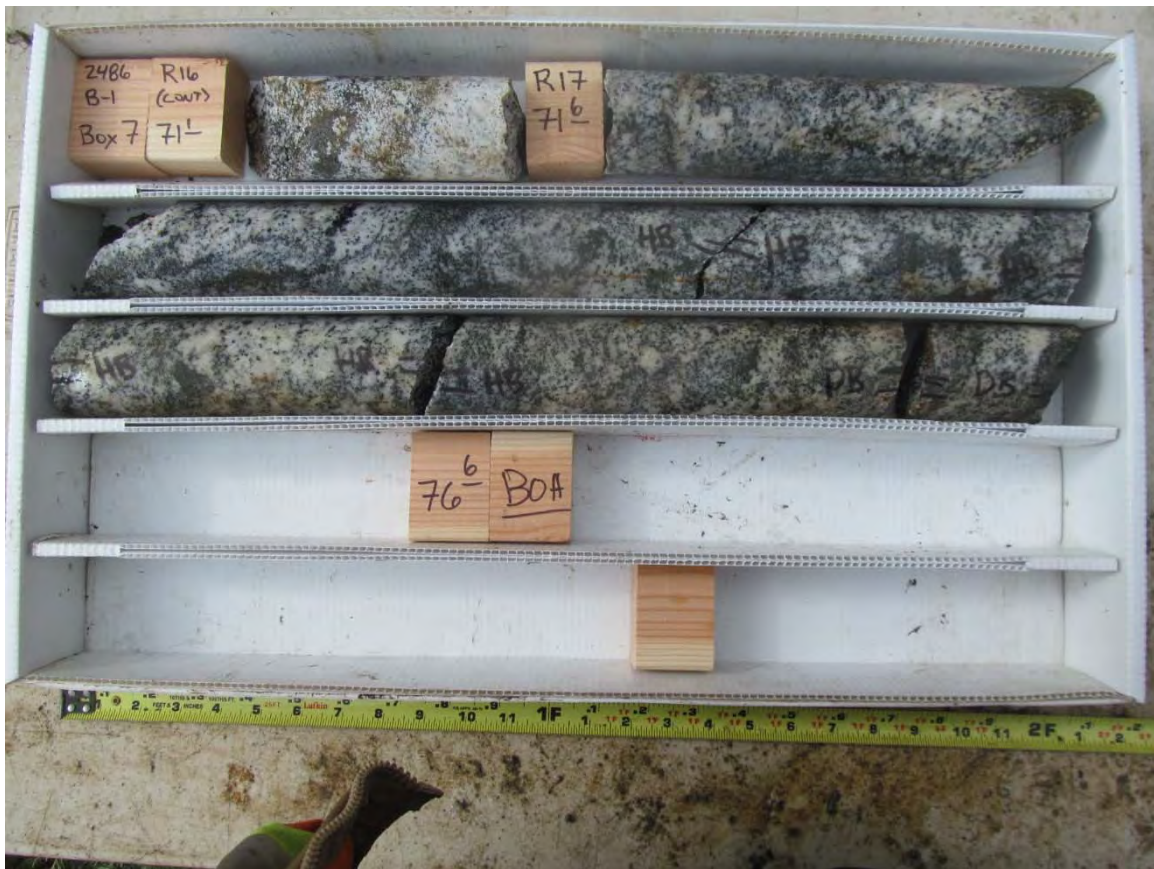
Box 4 – 48.2 feet to 57.0 feet.



Box 5 – 57.0 feet to 63.9 feet.



Box 6 – 63.9 feet to 71.1 feet.



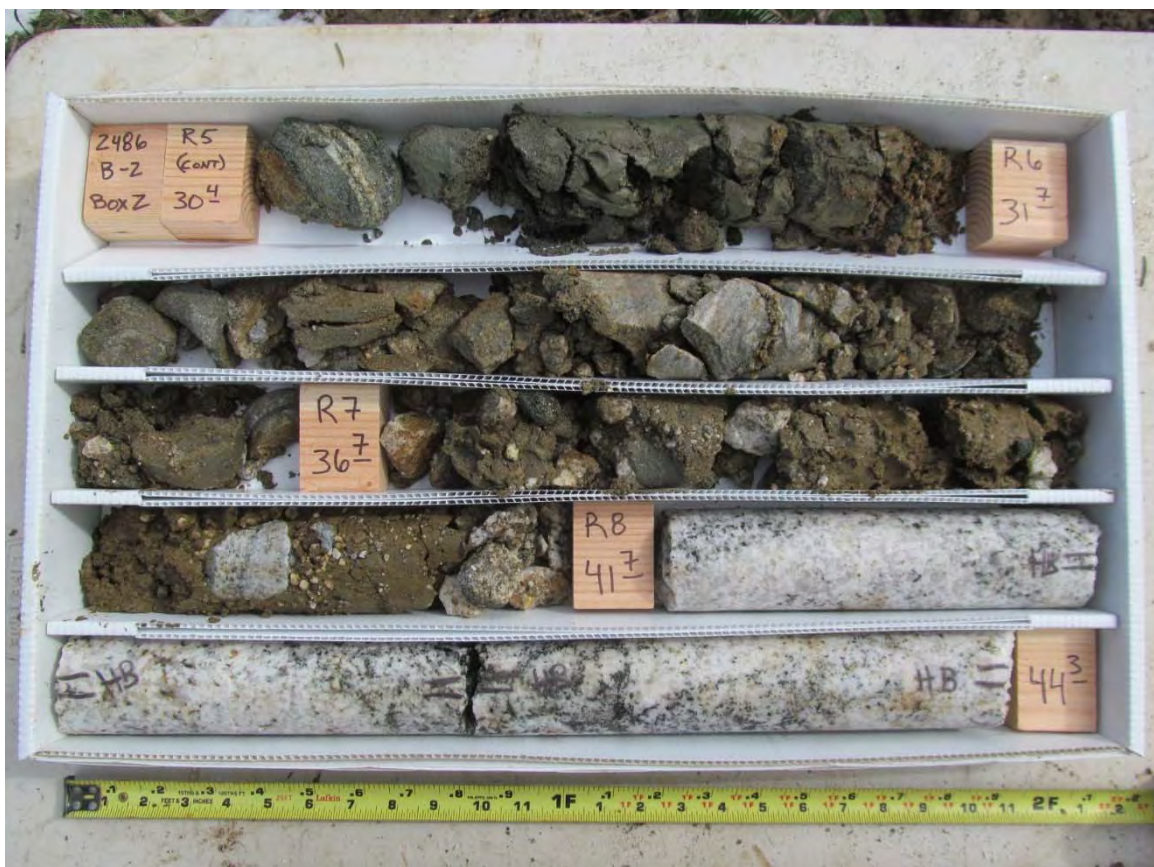
Box 7 – 71.1 feet to 76.6 feet.

| DEPTH IN FEET | MATERIAL DESCRIPTION | RUN NO. | SAMPLE | | GROUND WATER/ INSTRUMENT INSTALLATION | PENETRATION TEST (BLOWS PER FOOT) | | | | LEGEND |
|--|---|------------|--|--------------|--|--|------------------|--|-----------------------------------|--|
| | | | NO. | PEN. DATA | | WATER CONTENT (%) 10 20 30 40 | | | | |
| 9.7 | Set HWT Casing to 9.7 feet. No Samples Taken | | | | | | | | | <div><div><div></div><div>2-INCH O.D. SPLIT SPOON</div></div><div><div></div><div>3-INCH O.D. SPLIT SPOON</div></div><div><div></div><div>3-INCH O.D. THIN WALL SAMPLER</div></div><div><div></div><div>3-INCH O.D. PITCHER TUBE SAMPLER</div></div><div><div>*</div><div>NO SAMPLE RECOVERY</div></div><div><div>MM/DD/YY</div><div>GROUND WATER LEVEL AND DATE OBSERVED</div></div><div><div></div><div>LIQUID LIMIT</div></div><div><div></div><div>WATER CONTENT</div></div><div><div></div><div>PLASTIC LIMIT</div></div><div><div>▲</div><div>STANDARD PENETRATION TEST (BLOWS/FT.)</div></div><div><div>●</div><div>WATER CONTENT IN PERCENT</div></div><div><div></div><div>CORE RECOVERY IN PERCENT</div></div><div><div></div><div>RQD IN PERCENT</div></div><div><div>PT-1</div><div>PACKER TEST INTERVAL</div></div></div> |
| | LOOSE to MEDIUM DENSE, gravel- to boulder-sized rock fragments in a matrix of silty SAND to slightly clayey SILT; angular to sub-rounded rock fragments, decomposed, friable to medium hard fragments, micaceous, occasional diced texture (SLIDE DEBRIS) | R-1 | | | | | | | | |
| | | R-2 | | | | | | | | |
| | | R-3 | | | | | | | | |
| | | R-4 | | | | | | | | |
| | | R-5 | | | | | | | | |
| | | R-6 | | | | | | | | |
| | | R-7 | | | | | | | | |
| | | | | | | 20 40 60 80 | RECOVERY/RQD (%) | | | |
| HAMMER ASSEMBLY: NOT APPLICABLE SPT SAMPLER: NOT APPLICABLE | | | | | | | | | | |
| DRILL ROD USED: NOT APPLICABLE BOREHOLE DIAM.: 4" | | | | | | | | | | |
| DRILLER: CRUX SUBSURFACE DATE START: 3/27/2016 FINISH: 3/28/2016 DRILLING TECHNIQUE: HWT CASING ADVANCER/HQ3 CORING | | | <div><div><div></div><div>LANDSLIDE TECHNOLOGY</div></div><div>10250 S.W. Greenburg Road, Suite 111 Portland, Oregon 97223 Phone 503-452-1200 Fax 503-452-1528</div></div> | | | SUMMARY BORING LOG B-2 (1 of 2) SH-14 SLIDE REPAIR NEAR ELK CITY IDAHO COUNTY, ID | | | APR 2016 PROJ 2486 FIG. C-2 | |

| DEPTH IN FEET | MATERIAL DESCRIPTION | RUN NO. | SAMPLE | | GROUND WATER/ INSTRUMENT INSTALLATION | PENETRATION TEST (BLOWS PER FOOT) | | | | LEGEND |
|------------------|---|------------|--------|--------------|--|--|--|--|--|--|
| | | | NO. | PEN. DATA | | WATER CONTENT (%) 10 20 30 40 | | | | |
| 41.7 | ...diced texture from 39.7 to 41.7 feet. | R-7 | | | | | | | | <div><div><div><div></div></div><div>2-INCH O.D. SPLIT SPOON</div></div><div><div><div></div></div><div>3-INCH O.D. SPLIT SPOON</div></div><div><div><div></div></div><div>3-INCH O.D. THIN WALL SAMPLER</div></div><div><div><div></div></div><div>3-INCH O.D. PITCHER TUBE SAMPLER</div></div><div><div><div>*</div></div><div>NO SAMPLE RECOVERY</div></div><div><div><div>MM/DD/YY</div><div>▼</div></div><div>GROUND WATER LEVEL AND DATE OBSERVED</div></div><div><div><div></div><div></div><div></div></div><div>LIQUID LIMIT WATER CONTENT</div><div>PLASTIC LIMIT</div></div><div><div><div>▲</div></div><div>STANDARD PENETRATION TEST (BLOWS/FT.)</div></div><div><div><div>●</div></div><div>WATER CONTENT IN PERCENT</div></div><div><div><div></div></div><div>CORE RECOVERY IN PERCENT</div></div><div><div><div></div></div><div>RQD IN PERCENT</div></div><div><div><div>PT-1</div><div>PACKER TEST INTERVAL</div></div></div></div> |
| | MEDIUM HARD to HARD (R3-R4), brown to gray, moderately weathered GNEISS; very highly to highly fractured, fractures 30-50° (smooth, planar) dominant, clay infilling in fractures up to ½-inch, iron staining on fractures, occasional diced texture, folded, phaneritic, pegmatitic veins, micaceous | R-8 | | | | | | | | |
| | | R-9 | | | | | | | | |
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| | | R-10 | | | | | | | | |
| | | | | | | | | | | |
| | | R-11 | | | | | | | | |
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| | | R-12 | | | | | | | | |
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| | | R-13 | | | | | | | | |
| | | | | | | | | | | |
| | | R-14 | | | | | | | | |
| | | | | | | | | | | |
| 55.3 | ...diced texture from 53.9 to 54.3 feet. | | | | | | | | | |
| | MEDIUM HARD to HARD (R3-R4), gray, moderately weathered GNEISS; very highly to highly fractured, fractures 60-80° (smooth, planar) dominant, iron staining on fractures up to 6-inches, folded, phaneritic, pegmatitic veins, micaceous, trace slickensides (BIOTITE GNEISS and SCHIST) | | | | | | | | | |
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Box 1 – 9.7 feet to 30.4 feet.



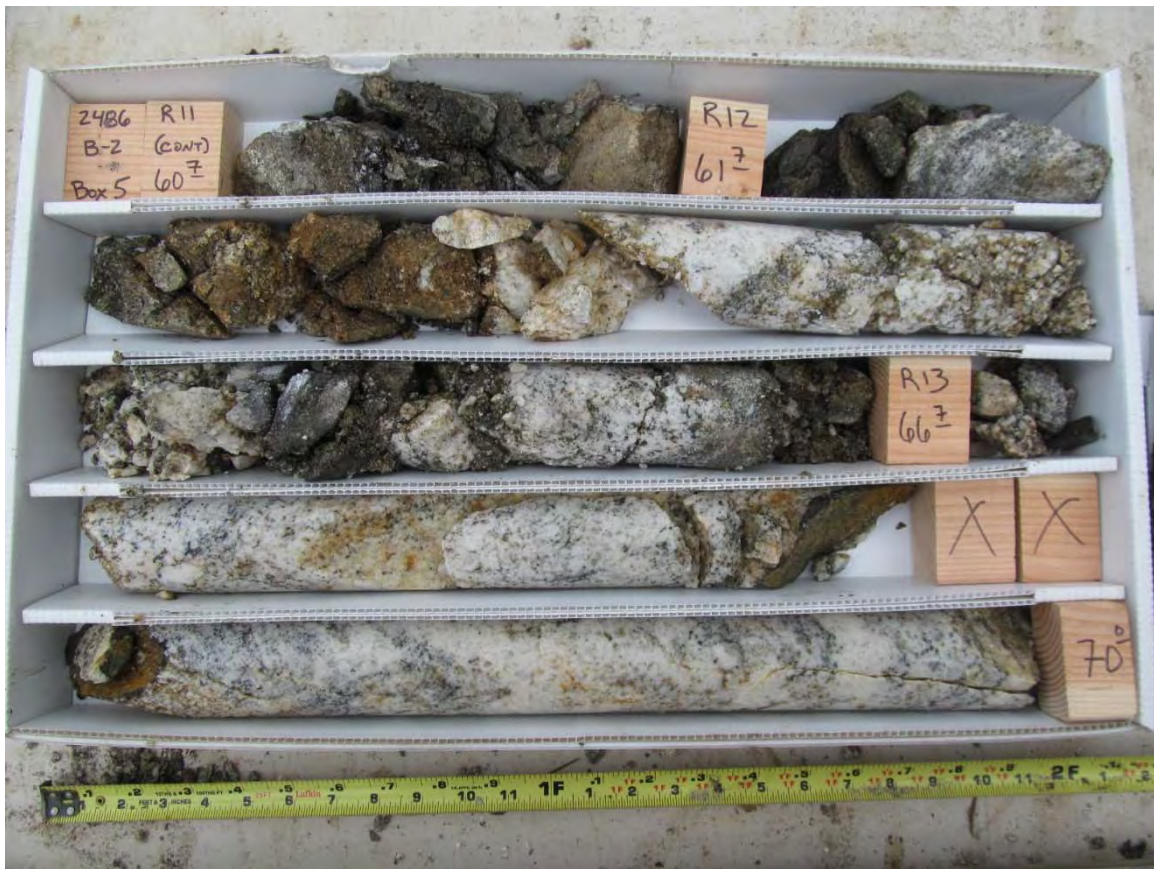
Box 2 – 30.4 feet to 44.3 feet.



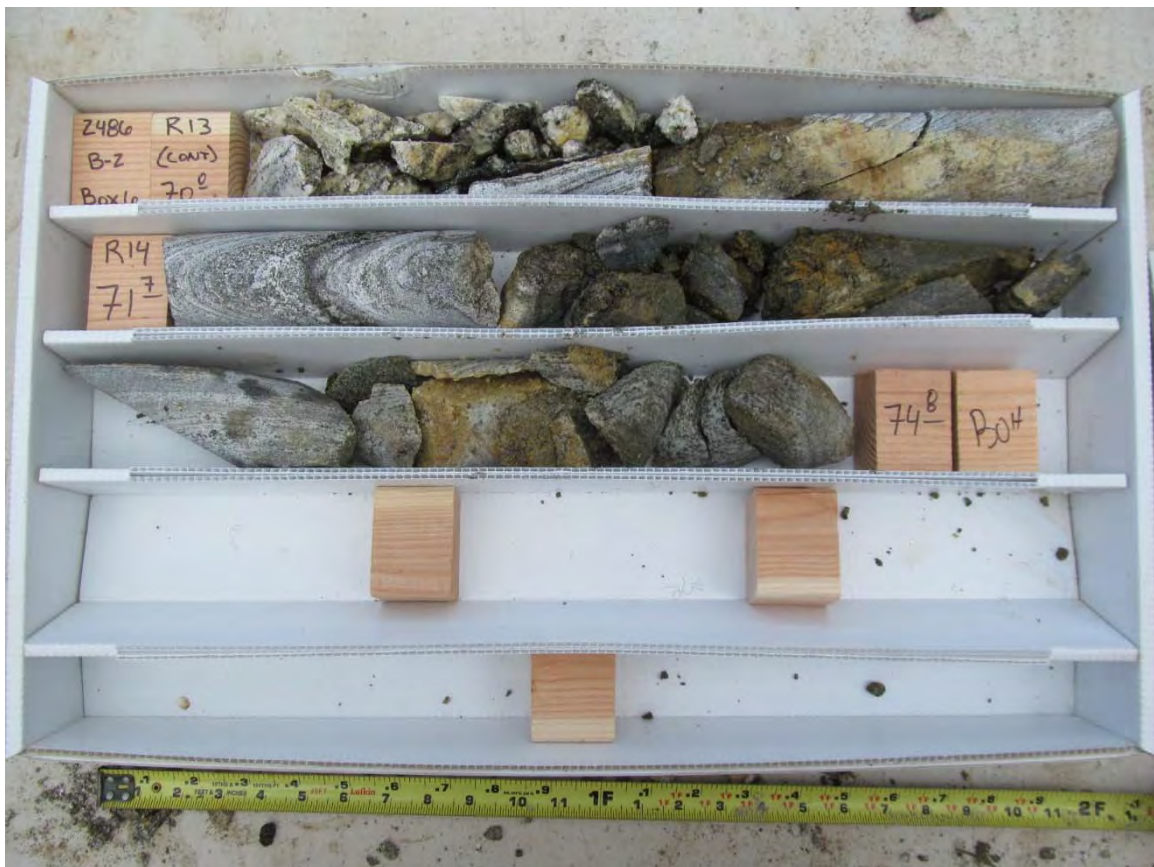
Box 3 – 44.3 feet to 53.5 feet.



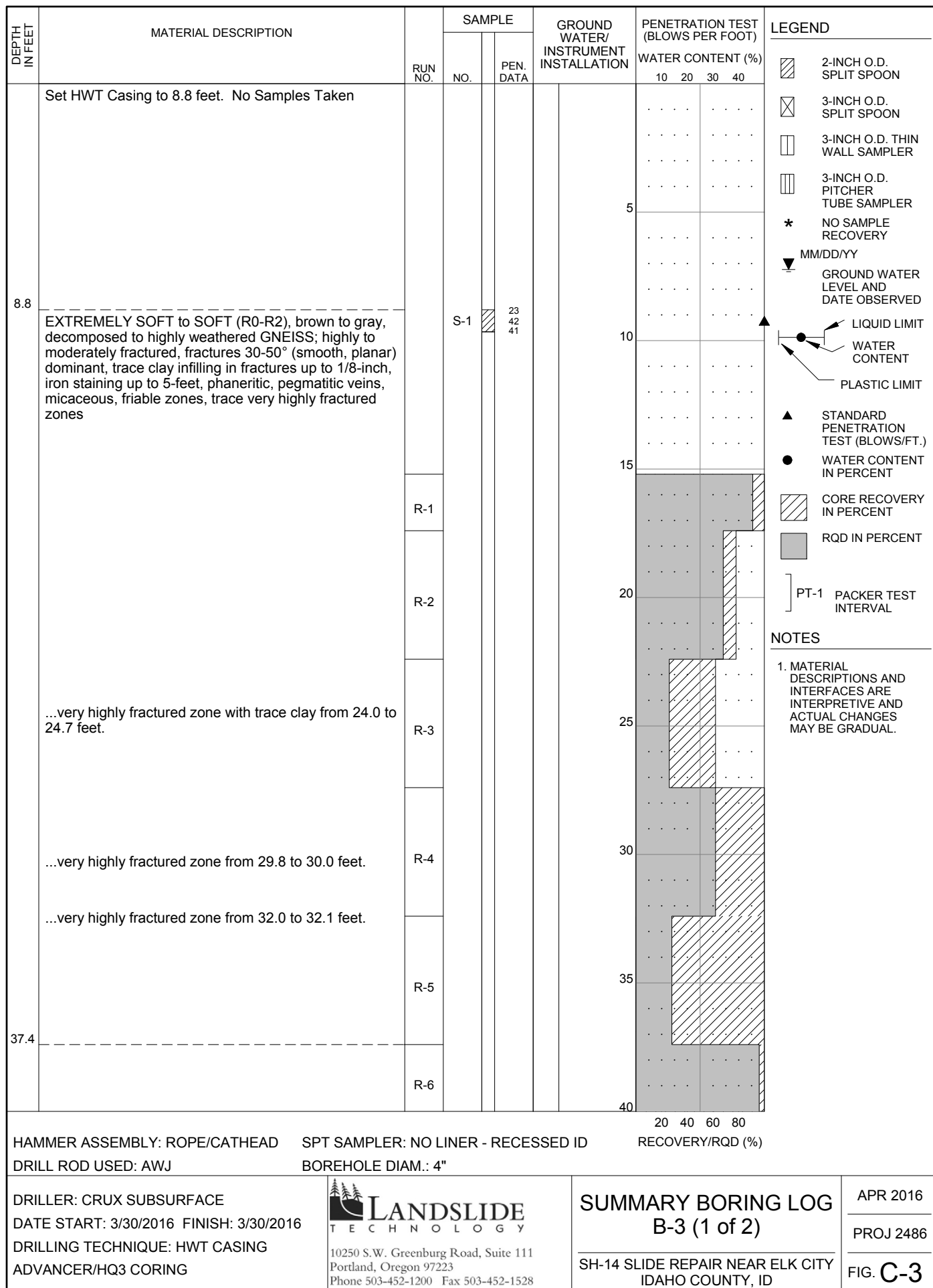
Box 4 – 53.5 feet to 60.7 feet.

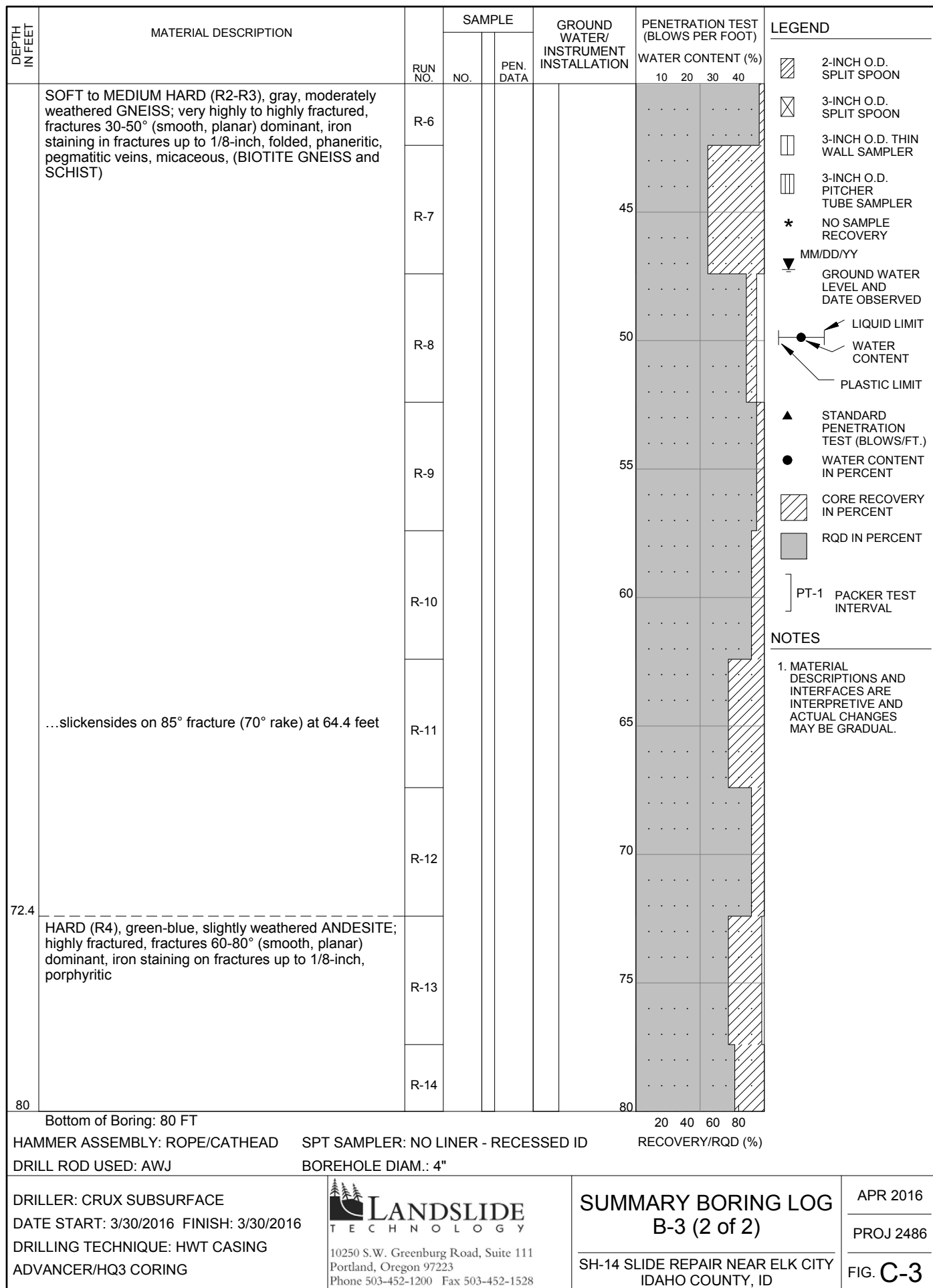


Box 5 – 60.7 feet to 70.0 feet.



Box 6 – 70.0 feet to 74.8 feet.







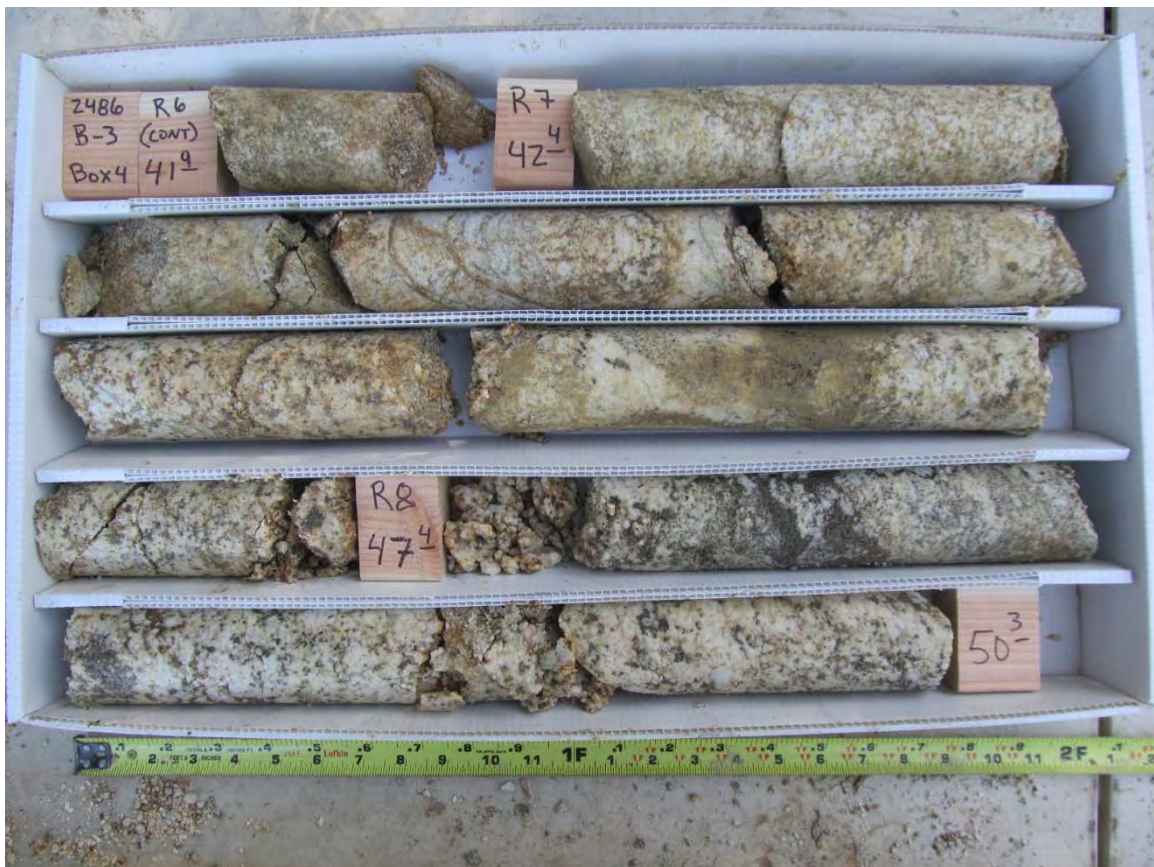
Box 1 – 15.2 feet to 25.8 feet.



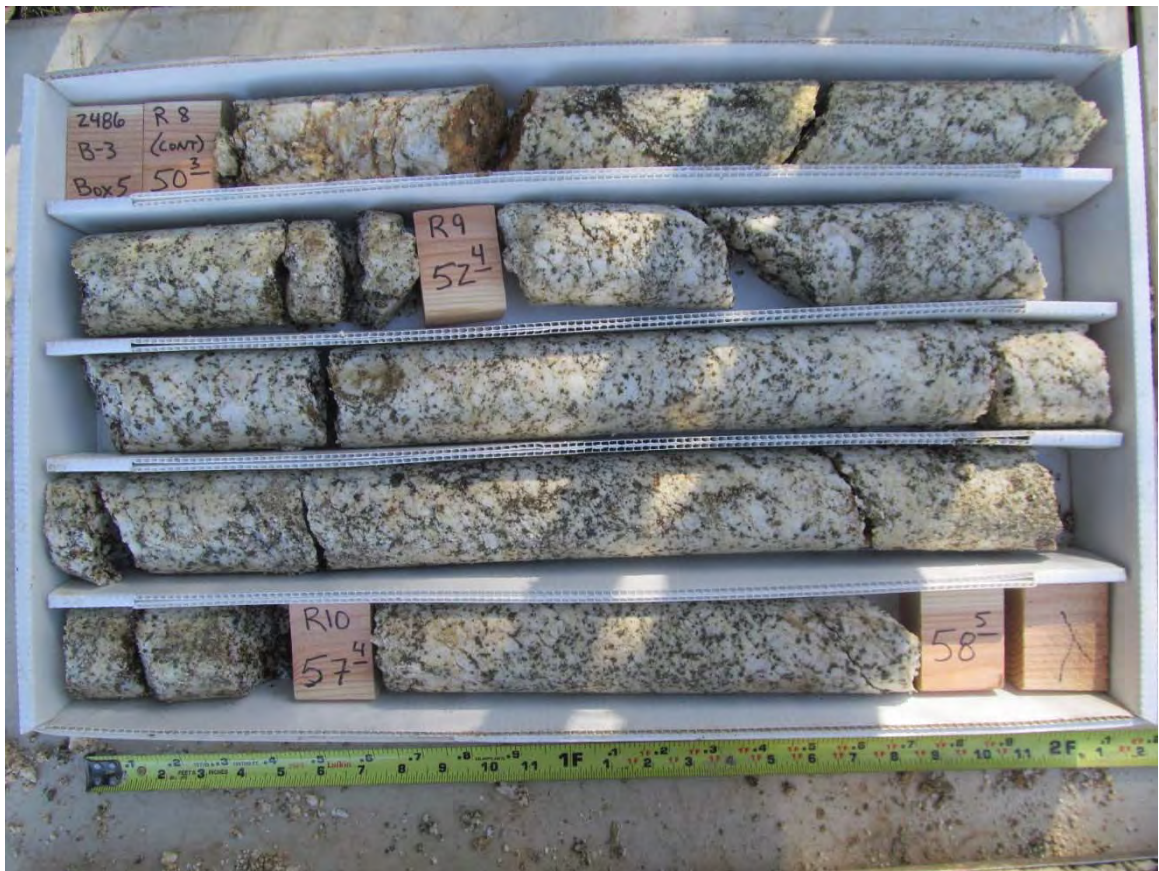
Box 2 – 25.8 feet to 33.6 feet.



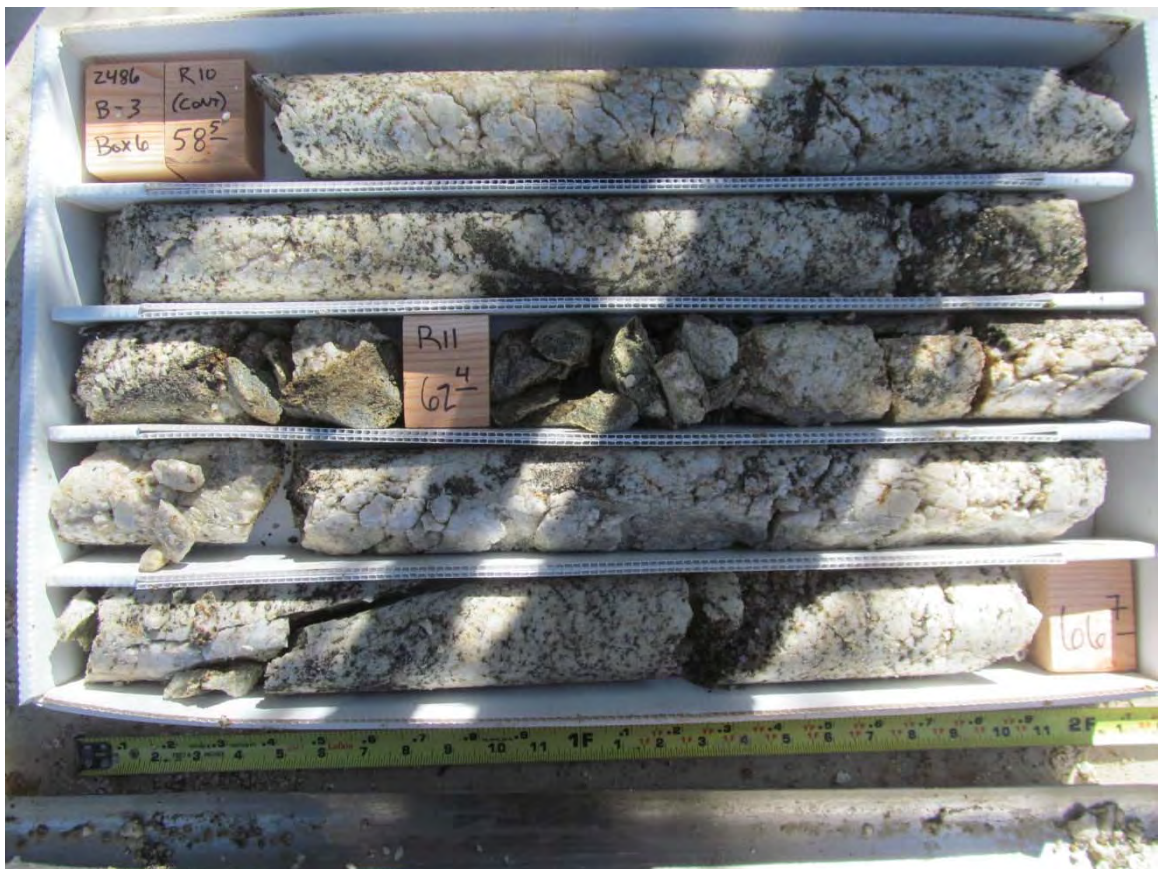
Box 3 – 33.6 feet to 41.9 feet.



Box 4 – 41.9 feet to 50.3 feet.



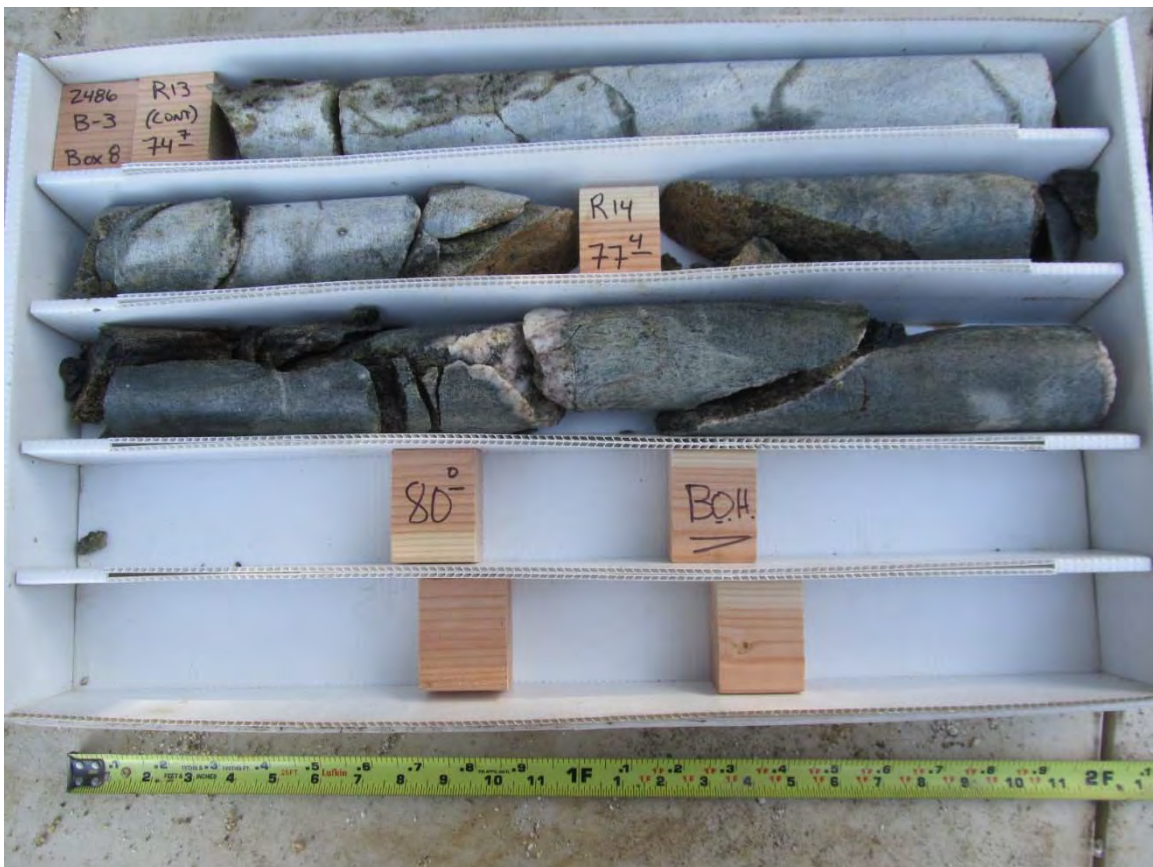
Box 5 – 50.3 feet to 58.5 feet.



Box 6 – 58.5 feet to 66.7 feet.



Box 7 – 66.7 feet to 74.7 feet.



Box 8 – 74.7 feet to 80.0 feet.

Appendix D

Rock Dowels and Unlined Drain Recommendations and Quantities Memo

Memo to: Bob Schumacher, P.E. 2486
Maintenance Supervisor, Project Manager
Idaho Transportation Department

From: Brent Black, C.E.G., P.G.
Adam Koslofsky, C.E.G.
Landslide Technology

Date: April 13, 2016

Subject: Rock Dowel and Unlined Drain Recommendations and Quantities
SH-14, Slide Repair Near Elk City, Idaho
Project No. A019(782), Key No. 19782

In accordance with your request, we have we have developed recommendations for rock dowels to reinforce potentially unstable rock slabs encountered during the excavation of landslide debris at the slide at MP 38, on SH-14 near Elk City. In addition, we have provided recommendations for unlined drains to relieve groundwater pressures within in the final excavated rock slope face. Recommendations include the following:

Work Items

The number, locations, lengths, and orientations of both the rock dowels and unlined drain holes will be determined in the field by ITD's Field Representative based on observations of the excavation slopes and the conditions encountered. For estimating purposes, we have assumed 2,000 linear feet may be required. This could include 75 to 150 rock dowels that are anticipated to be 15 to 30 feet in length. We have estimated about 1,000 linear feet of unlined drains may be required. This could include 25 to 50 unlined drain holes that are anticipated to be between 30 to 50 feet in length. The rock dowels and unlined drains should be constructed in general accordance with the following recommendations and as shown in the attached exhibit.

Rock Dowel Recommendations

- Install rock dowels at locations, lengths, and orientations determined by ITD's Field Representative.
- Use No. 11 (1-3/8 inch diameter), Grade 75, all-thread steel anchor bolts for the dowels conforming to AASHTO M31.
- Supply steel plates that are not less than 9-inch by 9-inch by 1-inch thick.
- Furnish all necessary hardware such as beveled washers, flat washers and nuts.
- Apply corrosion protection to all steel including either full galvanization or epoxy coating.

- Corrosion protection paint should meet the requirements of Federal Specification MIL-P-21035 (Ships) - Galvanizing Repair Paint, High Zinc Dust Content.
- Epoxy coated bars and fasteners should be done in accordance with ASTM A-775 or ASTM 934.
- Attach centralizers approximately every 10 feet and as shown on Exhibit 1.
- Drill a nominal 3-inch diameter hole.
- Over drill the hole approximately 10 inches.
- Clear the drill holes of cuttings before dowel insertion and grouting.
- Insert dowel and centralizers upon completion of drilling and cuttings removal.
- Grout dowels within 3 days of insertion with a tremmied, single-staged grouting system, filling the hole from the distal end to the surface.
- Add grout as necessary to fully encapsulate each rock dowel, as determined by the ITD field representative.
- Use Type II non-shrink Portland cement grout mixed per the manufacturer's recommendation.
- Test rock dowels as directed by the ITD field representative to a load capacity between 10 and 20 kips using either a torque wrench or jack that has been calibrated within the last six months. Load to be determined by the ITD field representative.
- Measure the payment length of the dowel from the rock face to the distal end of the bar.
- Payment will be for all materials, equipment and labor necessary to install fully grouted rock dowels as accepted by the ITD field representative.

Unlined Drains

- Drill unlined drain at locations, lengths, and orientations determined by ITD's Field Representative.
- Incline drain holes between 5° and 20° upward from horizontal.
- Drill a nominal 2.5-inch diameter hole.
- Clear the drain holes of cuttings following drilling.
- Probe the drain hole once cleared to verify the open depth.
- Drill the drains from the upper elevation locations first to the lower elevations.
- Measure the payment length of the unlined drain hole from the rock face to the distal end of the hole.

- Payment will be for all materials, equipment and labor necessary to install the unlined drain holes as accepted by the ITD field representative.

Limitations in the Use and Interpretation of this Geotechnical Report

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross-sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.



NOTES:

1. PROVIDE MATERIAL AND WORKMANSHIP IN ACCORDANCE WITH THE PROVIDED RECOMMENDATIONS.
2. INSTALL ROCK DOWELS AT THE LOCATIONS, ORIENTATIONS, AND LENGTHS AS DETERMINED BY ITD'S FIELD REPRESENTATIVE.
3. FIRST STAGE GROUT TO FILL ROCK DOWEL LENGTH FROM DISTAL END WITH GROUT TO THE SURFACE.